A Supported Liquid Membrane System for Steady State CO2 Control in a Spacecraft Cabin, Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

Reducing the allowable concentration of carbon dioxide (CO_2) in spacecraft is a critical need for NASA. The system now used on the International Space Station (ISS) is the carbon dioxide removal assembly (CDRA). While it has performed well on the ISS, managers have concluded that using the device to reach the new $ppCO_2$ limit of 2.0 mm Hg is not practical and a new method is needed.

In this project, Reaction Systems, Inc. and the University of Colorado will develop a new, membrane-based system to maintain $ppCO_2$ at no higher than 2.0 mm Hg. The system utilizes the recent advances made in supported liquid membranes (SLMs) to achieve the high CO_2 permeance and selectivity needed to make this approach practical. Performance data obtained with a Reaction Systems' SLM was used to produce a conceptual system design that indicates an SLM system can maintain CO_2 at 2.0 mm Hg and still meet size and power limits. A membrane system operates under steady-state conditions, and therefore pumps and heaters can be sized to operate at peak efficiencies, which maximizes lifetimes and minimize power requirements.

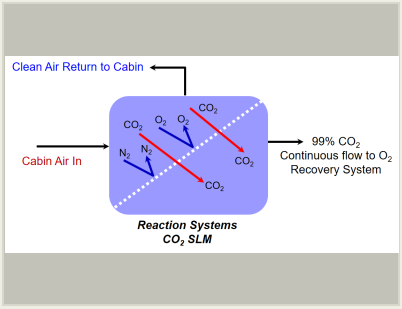
Although the conceptual design of the SLM-based system proposed here is very promising, some of the data used to generate the design were obtained under conditions somewhat different from those that would be encountered in an application. Thus, the objectives of this Phase I STTR project are to acquire performance data for these components under representative conditions and then perform a thorough system optimization study using state-of-the-art software to identify the most efficient operating conditions for all components.

Reaction Systems has been developing SLMs for CO_2 control for over seven years and our partner in this project, Professor James Nabity, in the Snead Aerospace Engineering Sciences Department at the University of Colorado in Boulder, has nearly 15 years of experience developing ECLSS technologies for space habitats and spacesuits.

Anticipated Benefits

The immediate application of this technology is the use of a steady state system to control of CO_2 in a spacecraft cabin to reach the $ppCO_2$ limit of 2.0 mm Hg. A system that operates under steady state conditions allows all components to be sized to operate under peak efficiency conditions and eliminates the need to store and compress CO_2 as it can be fed continuously into the O_2 recovery system. This SLM technology could also be used in a simple, reliable system to control CO_2 in a spacesuit.

This technology could also find use in capturing CO_2, a known greenhouse gas, from power plants. Atmospheric CO



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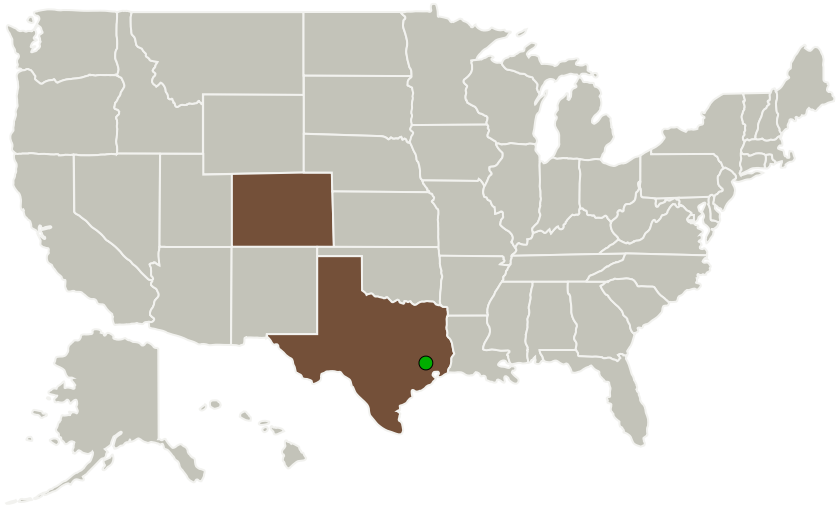
$_2$ has increased from 280 ppm to over 400 ppm over the last 60 years and there is evidence that the CO_2 atmospheric concentration is now affecting the world's climate. NOAA reports that the top 10 years of average surface temperatures have occurred in the last 12 years and Scientific American reports that 2016 was the hottest year on record and 2017 was the third hottest.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Reaction Systems, LLC	Lead Organization	Industry	Golden, Colorado
Johnson Space Center(JSC)	Supporting Organization	NASA Center	Houston, Texas
University of Colorado Boulder	Supporting Organization	Academia	Boulder, Colorado

Primary U.S. Work Locations	
Colorado	Texas

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Reaction Systems, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

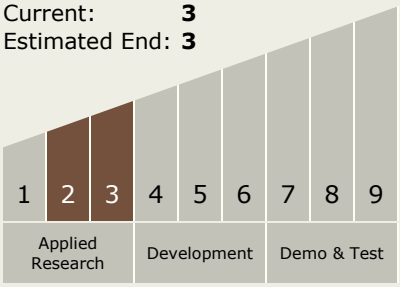
Carlos Torrez

Principal Investigator:

David Wickham

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



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Completed Technology Project (2018 - 2019)

Project Transitions

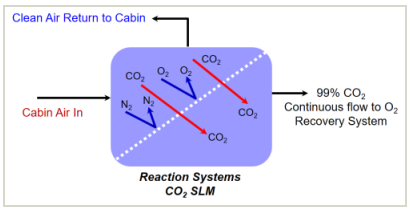
July 2018: Project Start

August 2019: Closed out

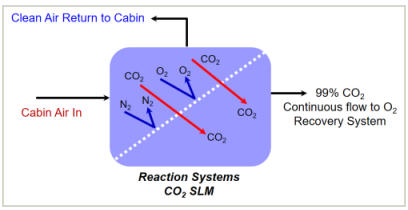
Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141202)*

Images



Final Summary Chart Image
A Supported Liquid Membrane System for Steady State CO2 Control in a Spacecraft Cabin, Phase I
(https://techport.nasa.gov/image/131166)



Project Image
A Supported Liquid Membrane System for Steady State CO2 Control in a Spacecraft Cabin, Phase I
(https://techport.nasa.gov/image/135526)

Technology Areas

Primary:

- TX06 Human Health, Life Support, and Habitation Systems
  - TX06.1 Environmental Control & Life Support Systems (ECLSS) and Habitation Systems
    - TX06.1.1 Atmosphere Revitalization

Target Destinations

Earth, The Moon, Mars